Detection Mechanism Of Carbon-Epoxy Enzyme Based Sensors

M. K. Khurana[1*], C. P. Winlove[2] and D. O'Hare[3]
[1]Imperial College of Science, Technology and Medicine, [2]University of Exeter, [3]University of Brighton
[1]PFSG, DBAMS, Roderic Hill Building, Prince Consort Road, London SW7 2BY, UK; [2]School of Physics, Exeter EX4 4QL, UK; [3]Department of Pharmacy, Cockcroft Building, Moulsecoomb, Brighton BN2 4GJ, UK.
***m.khurana@ic.ac.uk**

Though carbon sensors have been around since the late 1970s, very little is known about the detection mechanism. This is especially true for the bulk-modified enzyme-based biosensors. These types of sensors are appealing as they are relatively simple to construct and last for a long time as opposed to other techniques where the enzyme is immobilized on the sensor face. The epoxy makes the sensor robust, reusable and biocompatible as compared to the carbon paste sensors. Metallised carbon has known to lower the operating potential and he enzyme provides specificity towards the analyte.

We have developed a biosensor using rhodium-on-carbon and epoxy resin as the composite. Glucose and lactate oxidases were utilised as the substrate recognition layer in the respective sensors.

Oxidase enzyme-based biosensors rely on the detection of hydrogen peroxide, which is the end product of the enzyme reaction. The H_2O_2 is oxidised on the electrode surface and two electrons are released. We have tried to better understand this reaction using carbon epoxy and metallised-carbon epoxy oxidase enzyme-based biosensors that we developed for the detection of glucose and lactate. Most studies look at the substrate reaction on the biosensor as a whole. We have analysed the detection of H_2O_2 and compared bare carbon (C) epoxy and rhodium-on-carbon (Rh/C) epoxy electrodes.

An almost 100% increase in sensitivity to the H_2O_2 at 0 and 0.4 V was observed in the Rh/C electrodes as compared to the C epoxy. The rhodium acts as an electrocatalyst that enables this enhanced detection of hydrogen peroxide. Addition of the oxidase enzyme and the enzyme stabiliser polyethylenimine (PEI) into the composite further increased the sensitivity towards the H_2O_2 by about 60%.

To further understand this reaction, we investigated detection of H_2O_2 on FAD electrodes and found an increased sensitivity of about 40% in Rh/C+FAD electrodes as compared to the Rh/C electrodes. It was thus inferred that the increased sensitivity to H_2O_2 in the enzyme electrodes could be due to the co-enzyme FAD. Further, on incorporating FAD into the enzyme biosensors the overall sensitivity to the enzyme substrate was increased by as much as 50%. This increase in sensitivity could be accounted for by the semi-quinone in the FAD, which probably acts as an electrocatalyst towards the H_2O_2.